98-206

Exhibit 1
Technical Annex

Technical Annex
to
Comments of Northpoint Technology

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OUTLINE

INTRODUCTION

In this report, compatibility between Northpoint technology and a variety of satellite systems is examined. In section 1, the technical and operational characteristics of the Northpoint system are identified. With the exception of the discussion on availability, all of the information is taken from sources readily available and in the Public Record. In section 2, it is shown that Northpoint is fully compatible with DBS, and will not cause harmful interference into DBS systems. In section 3, interference from NGSO FSS systems is examined using both static and dynamic methods, and found to be significant from three systems (Hughes Net, Hughes Link and SkyBridge). An analysis of interference from Northpoint into NGSO FSS systems is performed in section 4, where it is shown that NGSO FSS systems are compatible with Northpoint, given that coordination is required.

1 OVERVIEW OF NORTHPOINT TECHNOLOGY SYSTEM[1]

The Northpoint Technology is an advanced low-power digital wireless technology to operate in the 12.2 - 12.7 GHz band under allocations to the fixed service (or broadcast service). A broadcast antenna is employed, which would be located on hills, mountains, towers or buildings, and can provide service to a southerly radius of 10-20 kilometers, depending on local conditions. For reception, the typical installation employs a 34 dBi gain antenna (ITU R F.1245). The system is designed to disseminate television, video and entertainment information. It is envisioned (subject to establishing a return link) that the Northpoint Technology could also be used for such high data rate applications such as video conferencing, and Internet connectivity.

1.1 System Characteristics of Northpoint Technology

The transmission parameters are similar to those parameters found in recommendation ITU-R F.755-1, Point-to-Multipoint Systems Used in the Fixed Service. The basic technical parameters are given in Table 1.

Table 1. Technical Parameters of the Northpoint Technology[2]

Parameter	Typical Value	Range	Units
Channel bandwidth	24	.001 - 500	MHz
Frequency	12.5	12.2 - 12.7	GHz
Polarization	H	H/V/C	-
Transmit antenna gain	10	9 - 13	dBi
Transmit Power	-25	-30 to 6	dBW
EIRP	-17.5	-21.5 to -7.5	dBW
Transmit height above average terrain	150	30 - 4500	meters
Transmit height above ground level	150	5 - 500	meters
Transmitter tilt above horizontal	3	0 - 5	deg
Required Signal Strength at edge of cell	-156	-155 to -160	dBi (24 MHz)
Cell Size	16	10 - 20	km

[1] Information about Northpoint system is taken from references 8 and 9.

[2] The parameters in the "Range" column are intended to provide guidance as to the typical range of values used in the majority of installations. The actual values will be determined by local conditions and specific application, (e.g. video, data, etc.). This is not to limit in any way the possibility of other values being used. For example, in cases of transmitters on mountaintops, the transmitter height above the average terrain could be 2000 meters. In this case, the allowable EIRP may be much higher, and the transmitter tilt may be less than zero.

Receive antenna gain	34	34 - 38	dBi
Thermal noise floor	-144.1	-144.1	dBW/MHz
Availability objective	99.7	99.7 - 99.995	%

1.1.1 Transmitter Characteristics

The Northpoint Technology employs a transmit antenna with a peak gain of 10 dBi. Transmissions are oriented toward the South, facilitating sharing with geostationary systems. Typical radiation patterns (elevation and azimuth) are given in Figure 1and Figure 2. The typical transmitter tilt is 3 degrees above the horizon, and the typical transmitter height above average terrain (HAAT) is 150 meters.

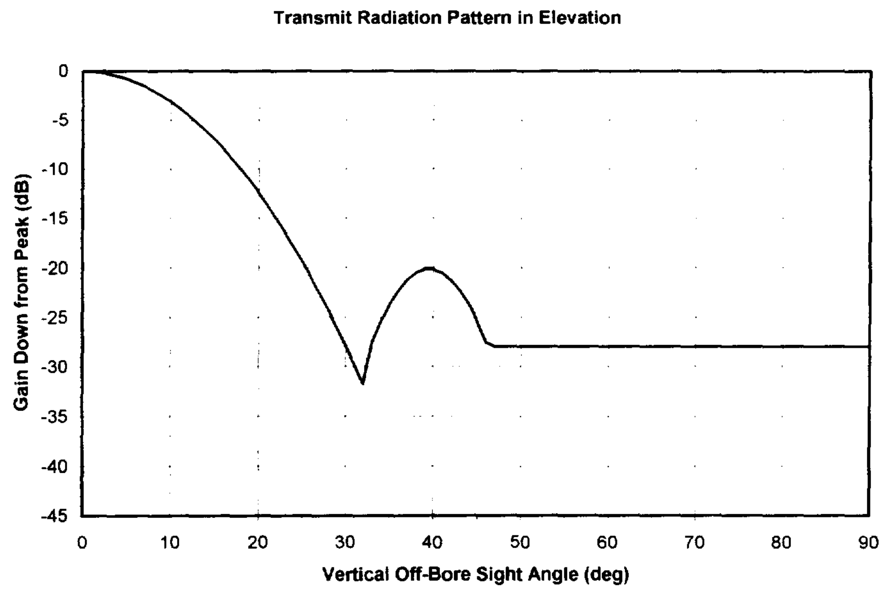

Figure 1. Transmitter Radiation Pattern in Elevation

The equations for computing relative transmit antenna radiation (from Gmax = 10 dBi) in elevation are given in Table 2.

Table 2. Northpoint Transmitter Radiation Pattern in Elevation

Off-Bore Sight Angle	Gain Down from peak (dBi)
$0 \leq \varphi < 32$	$0.031(\varphi)^2$
$32 \leq \varphi < 46.2$	$293.2 + 13.825(\varphi) + 0.175(\varphi)^2$
$46.2 \leq \varphi < 180$	28

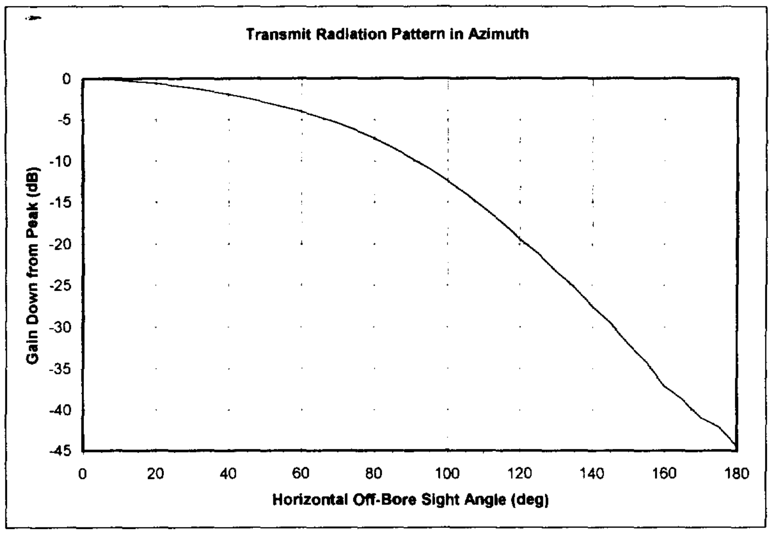

Figure 2. Transmitter Horizontal Radiation Pattern

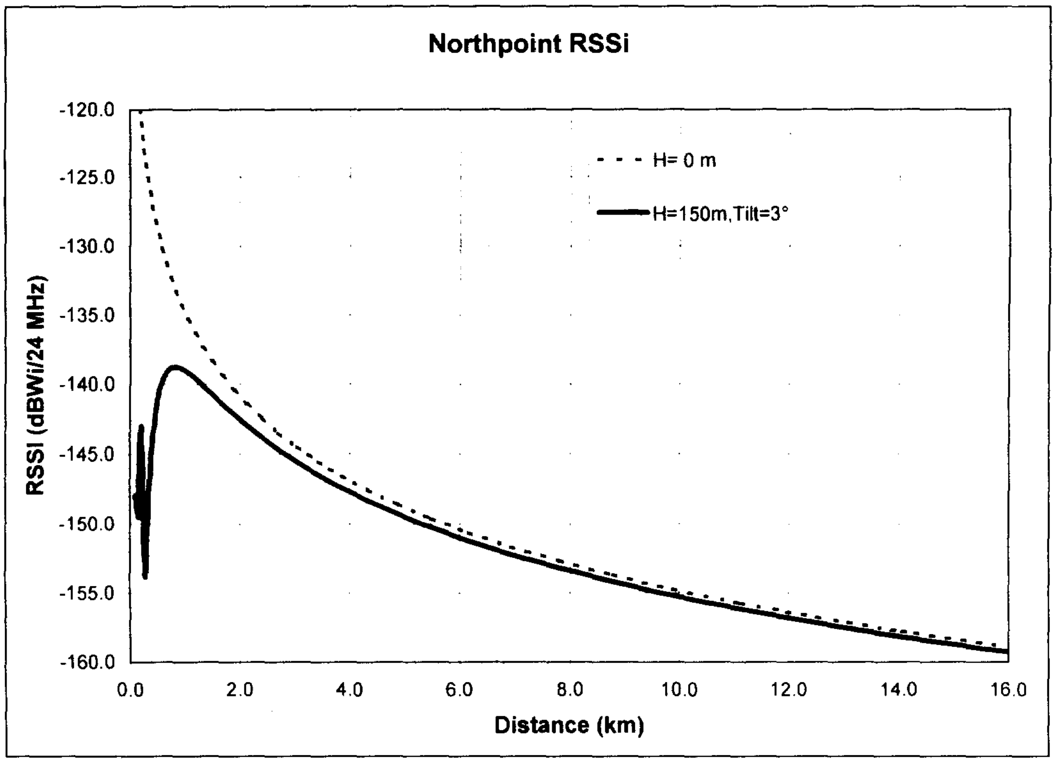

Figure 3. Northpoint Isotropic Signal Level, 24 MHz Bandwidth

Figure 3 depicts the Northpoint isotropic received signal level in a 24 MHz bandwidth, due south of the transmitter, for two cases:

(1) At transmitter height = 0 meters, no tilt

(2) At transmitter height = 150 meters, 3 degrees of beam tilt.

As can be clearly seen, the isotropic signal level peak value is about -139 dBWi/24 MHz, or -152 dBW/MHz.[3] The Northpoint Technology interference mitigation techniques reduce the power density levels near the transmitter significantly and are more fully explained in section 1.1.2.

1.1.2 Interference Mitigation from Northpoint Technology.

Northpoint Technology employs a variety of interference mitigation techniques to minimize interference and enhance the sharing environment.

Directional Transmission — Generally southward to minimize interference into satellite receivers.

Transmit Antenna Discrimination in the Vertical Plane — The Northpoint transmitter antenna pattern allows for 20-30 dB of discrimination in the area near the transmitter (See antenna pattern in Figure 1).

Beam Tilting— By tilting the transmitter up from the horizon, signal level is further reduced in the area of the transmitter, as shown in Figure 4.

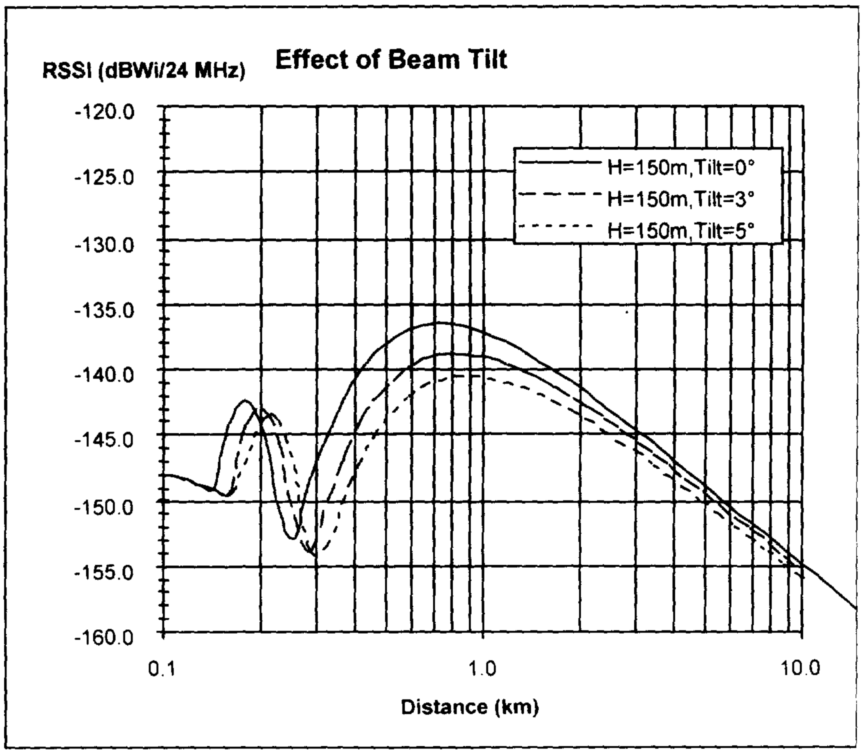

Figure 4. Effect of Beam Tilt on the Received Signal Strength relative to isotropic (RSSi).

Maximum Height Antenna Placement— Increased free space loss at transmitter heights of 50 meters or more (see Figure 5) significantly reduce the signal power in the area of the transmitter, by 15 - 30 dB.

[3] Figures 3 and 4 include 3 dB of isolation between linear and circular polarizations.

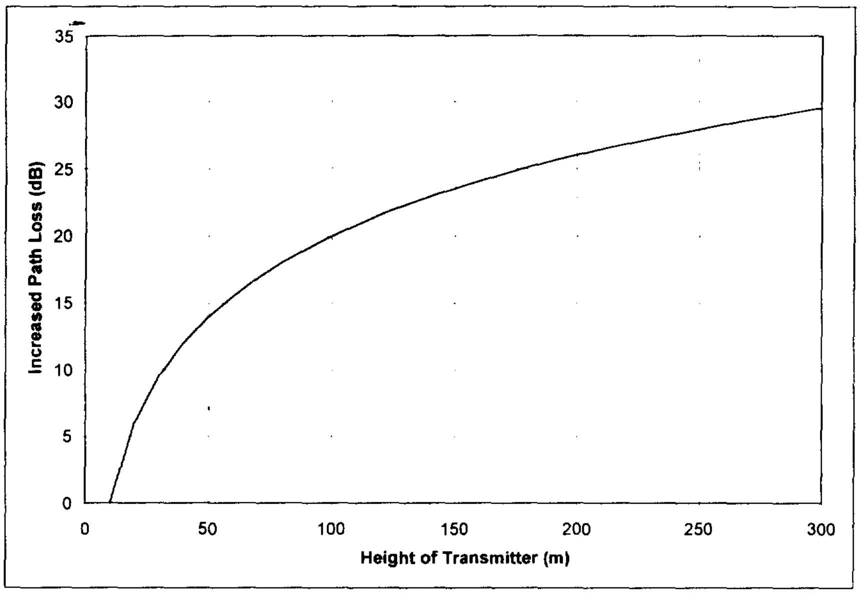

Figure 5. Increased Path Loss over 10 meter Transmitter Height

1.2 Northpoint Link Budget

The baseline Northpoint link budget is given in Table 3 for both clear air and rain, and for the variation on antenna gain.

Table 3 Northpoint Link Budget

Item	Clear Air	Rain, G = 34 dBi	Rain, G = 38 dBi	Units
Channel Bandwidth	24.0	24.0	24.0	MHz
Frequency	12.5	12.5	12.5	GHz
Availability	99.7%	99.7%	99.7%	%
Transmit Power	-25.0	-25.0	-25.0	dBW
Transmit Power	0.0032	0.0032	0.0032	Watts
Line Losses	-2.5	-2.5	-2.5	dB
Transmit Gain	10.0	10.0	10.0	dBi
EIRP	-17.5	-17.5	-17.5	dBW
Path Length	16.0	16.0	16.0	km
Path Loss	-138.4	-138.4	-138.4	dB
Atmospheric Loss	-0.2	-0.2	-0.2	dB
Rain Loss	0.0	-2.6	-6.6	dB
Isotropic RSS	-156.1	-158.7	-162.7	dBW
Receive Antenna Gain	34.0	34.0	38.0	dBi
Pointing Loss	-0.3	-0.3	-0.3	dB
C Received	-122.4	-125.0	-125.0	dBW
System Temp	284.0	284.0	284.0	°K
System Temp	24.5	24.5	24.5	dB-°K
G/T	9.5	9.5	13.5	dB/K
Boltzmann's	-228.6	-228.6	-228.6	dBW/Hz-K
Noise Figure kTB	-130.3	-130.3	-130.3	dB
Theoretical C/N Received	7.9	5.3	5.3	dB
C/N Required	5.0	5.0	5.0	dB
Theoretical	2.9	0.3	0.3	dB
Interference C/I	20	20	20	dB
Interference Degradation	0.3	0.3	0.3	dB

Margin	2.6	0.0	0.0	dB

1.3 System Availability and Service Area

In this section, the contributions to unavailability are examined and the service area is defined for various ITU-R rain regions. The service area is defined by the ability to receive a quality signal at the edge of coverage and at an availability between 99.7 and 99.9% or higher, depending on local rain region and topography.

1.3.1 Atmospheric Effects on Link Availability

Certain atmospheric effects, such as rain attenuation and other types of fading, influence link availability.

Rain Attenuation and Gaseous Absorption — The Northpoint link is designed for robust availability (99.7 - 99.9%), at the edge of coverage, throughout the U.S. In Figure 6 the rain margin, as a function of distance from the Northpoint transmitter, is shown taking into account variations in free-space loss. The Northpoint link budget, with a 34 dBi gain antenna, allows for 2.6 dB of degradation due to rain attenuation. At this level, reliable service can be provided everywhere in the U.S. at 10 -16 km from the transmitter, and more than 16 km in rain regions E, D and B, which comprise about 50% of the U.S.

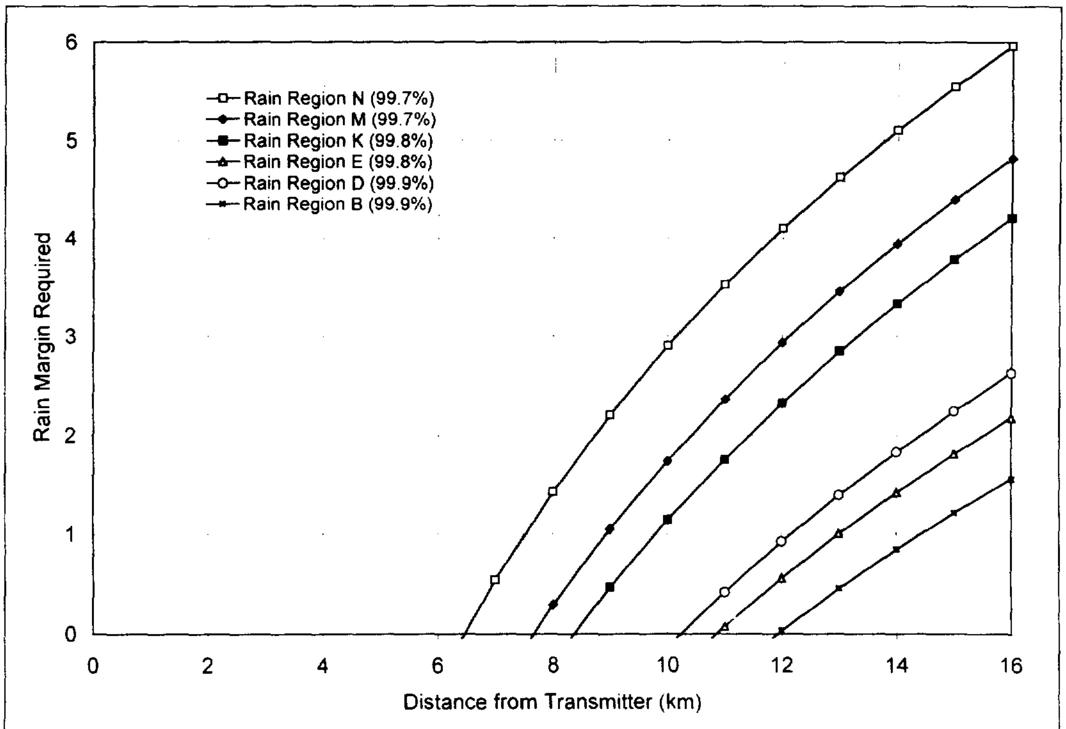

Figure 6. Rain Margin Requirements for all ITU-R rain regions in the U.S.

Moreover, the design of the Northpoint system provides an higher gain of 38 dBi in some circumstances. For those customers at the edge of coverage and in the higher rain attenuation areas, where the cell geometry dictates need for increased gain, a higher gain antenna provides for 4 dB of additional fade margin. With a higher gain receive antenna, cell sizes of 16 km throughout the country are assured. In any case, there is clearly sufficient margin to mitigate rain attenuation for all areas of the U.S.

Fading— Recommendation ITU-R P.530-7 provides a conservative estimate of fading, as described in Equation 1.

$$p_w = K\, d^{3.6} f^{0.89} \left(1 + |\varepsilon_p|\right)^{-1.4} \times 10^{-A/10} \qquad \% \qquad \text{(Equation 1)}$$

where:

p_w : Percent time of unavailability

$$K = 5.0 \times 10^{-7} \times 10^{-0.1(C_0 - C_{Lat} - C_{Lon})} p_L{}^{1.5} \qquad \text{(Equation 2)}$$

C_o : term to describe the terrain, ranges between 0 and 8 in the U.S.

p_L, : The climatic variable (i.e., the percentage of time that the refractivity gradient in the lowest 100 m of the atmosphere is more negative than −100 N units/km in the estimated average year.[4] For Northpoint in the U.S., p_L N varies between 5 and 15 on a yearly average basis.

f : frequency (GHz)

d : path length (km)

From the antenna heights h_e and h_r (m above sea level or some other reference height), calculate the magnitude of the path inclination $|\varepsilon_p|$ (mrad) from:

$$|\varepsilon_p| = |h_r - h_e| / d.$$

The results are plotted in Figure 7.

[4] Point-to-point applications design to worst-month unavailability. However, for this type of service it is more appropriate to design to a yearly average.

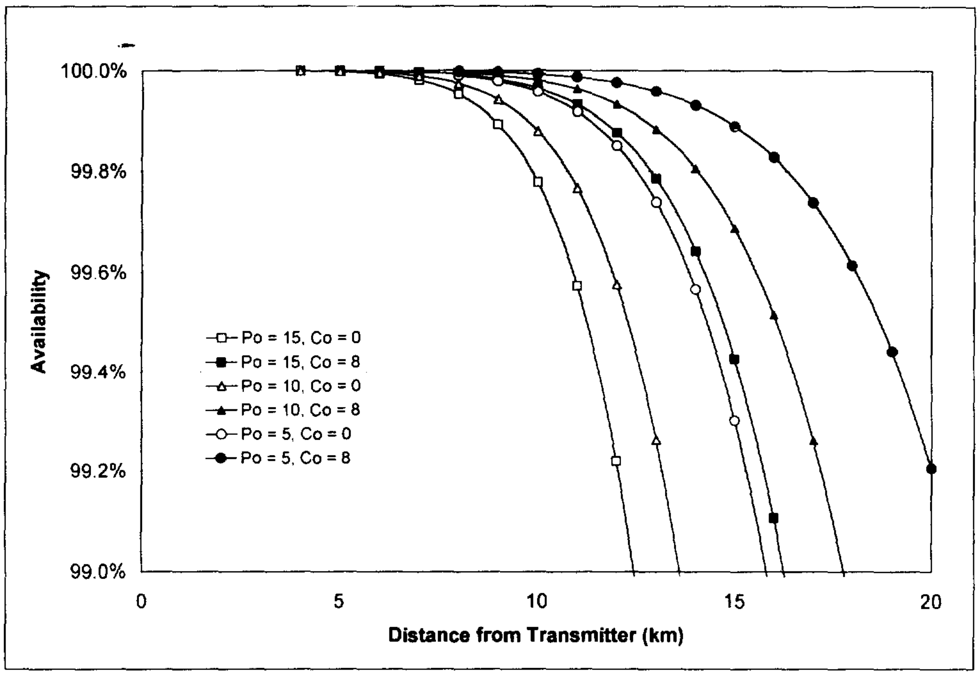

Figure 7. Northpoint Availability in Point-to-Point Fading Conditions

Clearly, Northpoint offers sufficient availability for cell sizes greater than 10 km, and in many parts of the country, for cell sizes of up to 18 km. Again, Northpoint has the option of using a 38 dBi gain antenna to provide additional fade margin, should this be necessary. With this option, cell sizes of 16 km throughout the country are assured.

However, note the heavy dependence on the refractivity gradient of equation 1. It is believed that the broadcast nature of Northpoint is sufficiently different from point-to-point systems. All fading estimates are based upon empirical data taken with much higher gain transmit antennas. Northpoint will not be as affected by fading as much as point-to-point systems are, which both transmit and receive with highly focused energy. As such, the estimate provided by Rec. P.530-7 overestimates the required fade margin. However, this can only be proven through the generation of empirical data over time.

Thus, a 2-3 dB margin for atmospherics provides sufficient margin for atmospheric effects at 99.7% availability and greater. In rare cases where additional fade margin is required, a higher gain antenna can be employed.

1.3.2 Availability Reduction due to Interference.

The Northpoint Link Budget allows 0.3 dB degradation due to fixed sources of interference. The rain margin of 2.6 dB can also be used to mitigate time varying sources of interference.

Interference due to GSO BSS and FSS systems— As discussed in reference 6, where an estimate on the amount of interference from GSO systems is made, Northpoint receiver elevation angles at edge of coverage will be below 2 degrees. At this elevation, the off bore-sight discrimination to the GSO arc from a Northpoint receiver will be between 35 and 50 dB, depending on the relative azimuth of the GSO to the antenna boresight. At the edge of the service area, the received isotropic signal levels are equivalent for the GSO systems and for Northpoint, and therefore, the C/I ratio will be at least 35 - 50 dB. Even with as many as ten GSO systems in view, the aggregate C/I would be no greater than 30 dB, and this will be at least 20 dB below the noise level of the Northpoint receiver. Thus, signal degradation due to interference from the

GSO will be less than 0.1 dB, even at the edge of coverage. This level of link degradation will cause less than 0.01% reduction in availability.

Interference due to NGSO FSS— The rain and fade margin of 2.6 dB can also be used to mitigate time varying sources of interference. If NGSO FSS systems meet the interference criteria presented in section [] then the aggregate interference from NGSO FSS systems will contribute to less than 0.01% of the total unavailability.

Interference due to other terrestrial systems— There is a general paucity of terrestrial systems in the band. Interference from other terrestrial sources of interference is assumed to be at C/I of 30 dB or greater, and thus will not cause a reduction in availability of more than 0.01%.

1.3.3 Reduction in availability due to equipment outages.

Transmit equipment technology is mature, and an equipment availability of 99.99% or higher can be expected.

1.3.4 Northpoint System Availability

The previous sections demonstrated that the Northpoint link budget is designed to provide a minimum 99.7% of availability at edge of coverage, which is the same as DBS. However, all customers within the service area will experience higher availability, and the average availability is higher than 99.95%. Northpoint has the option of providing higher gain antennas to edge-of-service customers in certain parts of the country where additional fade margin may be desired.

1.3.5 Northpoint Service Area.

The Northpoint Service area is shown in Figure 8 for Rain Regions B, D and E. For other parts of the country, the maximum distance may be slightly shorter, but in all cases will be at least 10 km.

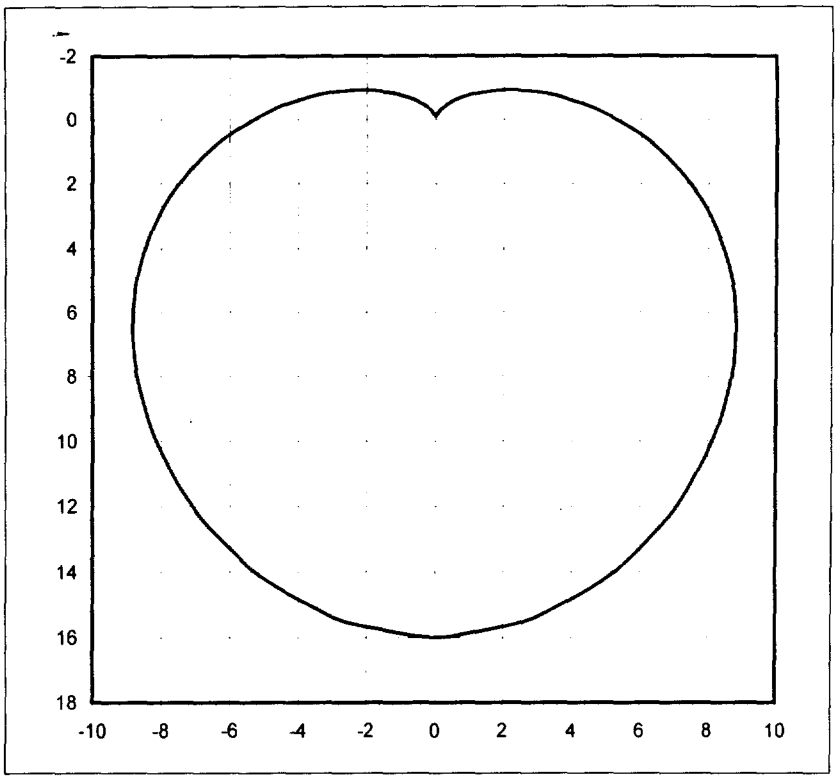

Figure 8. Northpoint Service Area, (ITU Rain Regions B, D and E)

1.4 Possible Implementation of Multiple Northpoint Systems

As shown in the previous section, interference from other terrestrial emissions was assumed to be at C/I values of 30 dB or greater. In Figure 8, it is clear that if there were another broadcast transmitter in the cell, there would be interference. Given the broadcast nature of the system, with a second broadcast transmitter in the cell, there will be geometry where there is line of sight and main-beam on main-beam interference. Moreover, segmentation of the band will not provide sufficient capacity to offer a competitive service. If less than 500 MHz could be used to provide a competitive service, then DBS could use less than 500 MHz as well.

2 NORTHPOINT COMPATIBILITY WITH DBS

In this section it will be demonstrated that a terrestrial interference value of C/I = 8 dB will not cause harmful interference into DBS. Moreover, that Northpoint minimum C/I will be 20 dB in 99.8% of the service area, and 17 dB of isolation in 100% of the service area. A careful examination is made of the typical DBS link budget, throughout the U.S, in a variety of rain regions and latitudes.

2.1 DBS Interference Criteria

The Commission requested comment on protection criteria for DBS. Harmful interference is defined as repeatedly interrupting or seriously degrading service. In order to cause harmful interference, a terrestrial service would need to repeatedly interrupt or seriously degrade the signal. DBS availability is specified as a minimum of 99.7%[5], for an unavailability of 0.3%, or 26.3 hours per year. A serious degradation of the DBS signal would significantly increase the outage level beyond 26.3 hours per year. In *Terrestrial Interference in the DBS Downlink Band,* DirecTV asserts that a 20% increase in unavailability (an increase to 31.5 hours per year) would seriously degrade the signal reception. As demonstrated herein, noise from Northpoint will be significantly below that level that would cause a 20% increase in unavailability.

Based upon a stated availability of 99.7%, a 0.01% decrease in availability equates to an increase of 3.4% in unavailability. Recent documents from the ITU JTG 4-9-11[6] and ITU WP 10-11S[7] identifies that an aggregate 10% increase in unavailability from NGSO FSS systems is acceptable, and has been accepted by the experts in the U.S. DBS industry. If a 10% unavailability allocation to NGSO FSS were acceptable, then a 10% unavailability from terrestrial systems would also be acceptable. This would be below the 20% increase in unavailability deemed acceptable by DTV in the 1994 report on terrestrial interference. However, Northpoint will be below a 10% increase in unavailability.

Further, as demonstrated herein, an increase in unavailability occurs in a mitigation zone that is less than 0.2% of DBS households. It should be taken into account that the vast majority (>99%) of DBS households will have link degradation less than 0.1 dB. If average degradation in the service area would be taken into account, then Northpoint would cause an average decrease availability far less than 0.0001%. Assume that terrestrial systems would cause a 10% increase in unavailability (reduction in availability of 0.03%, or 2.6 hours per year) in 0.2% of the service area. Then, the average DBS customer would have an increase in outage time of (2.6 hours * 0.2%) 18 seconds per year.

2.1.1 DBS Link Budget, With Rain

In order to understand the potential impact of terrestrial interference on a DBS signal, refer to the link budgets in Table 4. The bullets following the link budget describe the important assumptions therein. All of the assumptions contained in the link budgets were taken from DBS industry publications, FCC applications, and ITU documents.

Table 4. DBS Link Budget, With Rain.

	Austin	Bangor	Chicago	Los Angeles	Miami	Seattle	units
1. EIRP[8]	51.0	50.0	51.0	50.0	54.0	50.0	dBW

[5] Terrestrial Interference in the DBS Downlink Band, page 5.
[6] Reference 6
[7] Reference 5.
[8] Reference 3 at 8.

2. Downlink Path Loss	-205.6	-206.1	-205.9	-205.8	-205.7	-206.0	dB
3. Elevation Angle	54.6	29.3	39.3	46.3	52.0	31.3	deg
4. DBS Availability[9]	99.80%	99.70%	99.80%	99.90%	99.70%	99.85%	%
5. Atmospheric Loss[10]	-0.08	-0.13	-0.12	-0.09	-0.08	-0.13	dB
6. Rain Loss[11]	-1.8	-1.0	-1.6	-1.1	-3.6	-1.1	dB
7. Rain Temp Increase[12]	-2.5	-1.7	-2.3	-1.8	-3.6	-1.8	dB
8. Pointing Loss[13]	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	dB
9. Ground G/T	13.0	13.0	13.0	13.0	13.0	13.0	dB/K
10. Bandwidth	-73.8	-73.8	-73.8	-73.8	-73.8	-73.8	dB
11. Boltzmann's	228.6	228.6	228.6	228.6	228.6	228.6	dBW/Hz-K
12. Downlink C/N (Thermal)	8.5	8.7	8.6	8.7	8.5	8.4	dB
13. Uplink C/N	24.2	24.2	24.2	24.2	24.2	24.2	dB
14. Crosspol	22.7	22.6	22.5	22.8	22.1	22.6	dB
15. Adjacent Satellite Interference	25.0	25.0	25.0	25.0	25.0	25.0	dB
16. Total C/(N+I)	8.1	8.3	8.2	8.3	8.1	8.1	dB
17. Terrestrial Interference	**8.0**	**8.0**	**8.0**	**8.0**	**8.0**	**8.0**	dB
18. Total C/(N+I)	5.0	5.1	5.1	5.2	5.1	5.0	dB
19. C/N Required	5.0	5.0	5.0	5.0	5.0	5.0	dB
20. Link Degradation from Terrestrial	3.06	3.16	3.10	3.19	3.08	3.04	dB
21. Residual Margin	0.0	0.1	0.1	0.2	0.1	0.0	dB

Lines 1-10 - This information is contained in DirecTV authored documents on terrestrial interference, and in other sources.

Line 13, Uplink C/N - In the 1994 report this is given as 25 dB[14]. Recent communication from DirecTV indicates this value is 27.2 dB, [15] but a more conservative value of 24.2 dB is used[16].

Line 14- Isolation due to depolarized signal will be at least 22.1 dB down from the carrier. The calculation is given in Table 5, and explained in the bullets following the table.

Table 5. Calculation of minimum depolarization isolation, DBS Satellite at 101 W.

Line	Item	Value	Reference
A	Uplink	30	Appendix S30a
B	Satellite Transmitter Depolarization	30	Appendix S30, Annex 5, figure 10
C	Depolarization due to Rain (Worst Case)	29.7	Appendix S30, Annex 5, Section 2.3
D	Receiver Antenna Depolarization	25	Appendix S30, Annex 5, Figure 8[17]
E	Total	22.1	Power Sum of all Depolarization Sources

- Line A—Assuming rain on only the downlink. The joint probability of rain on both uplink and downlink is sufficiently low and can be ignored.
- Line B—30 dB minimum transmit isolation.

[9] Minimum of 99.7%, as given in References 3 and elsewhere.
[10] Will be below 0.15 dB for all elevation angles above 20 degrees, ITU-R model.
[11] Crane Rain Model.
[12] Reference 3 at 5.
[13] Reference 3 at 5. It is noted that in some documents this value is given as 0.5 dB, but in those cases no atmospheric loss is taken.
[14] Reference 2 at 5
[15] Reference 2 at 3.
[16] Reference 3 at 36.
[17] Recently Revised at WRC-97, the international standard is the most conservative.

- Line C—Appendix S30, Annex 5, Section 2.3 calculation for rain depolarization. This is the worst-case scenario, as represented in Miami, FLA.
- Line D—The figure of 25 dB for the receiver antenna depolarization given in Appendix S30 clearly applies for interference studies into the 45 cm dish currently in use in the U.S
- Line E—Power sum or all depolarization sources. Worst-case minimum isolation is 22.1 dB. The variation is dependent on depolarization due to rain, which is calculated for each specific site and rain attenuation, according to Appendix S30[18]

Line 15. Interference from adjacent satellites, at least 9 degrees longitude away will be at between 9.5 - 10.5 degrees off boresight. The BSS reference antenna pattern given in JTG 4-9-11/356-E, which is recommended for interference studies of this type, shows a minimum of 30 dB discrimination at 9 degrees off boresight. This value was also stated by DirecTV as 28.7 dB in Reference 2[19]. However, a more conservative value of 25 dB is used in these calculations, to account for satellites spaced every nine degrees, an unreasonably overly-conservative assumption.

Line 19 - C/N required. The required C/N for the lower convolutional coding rate is 5 dB as stated in multiple DTV documents, most recently in Reference 3.[20] There is no degradation in bit error rate at this value. This value has also been verified in testing by Northpoint. Note that for the higher convolutional coding rate of 6/7, DBS operates transmitters at higher power to compensate. These link calculations are done for the lower convolutional rate, but the terrestrial effect on interference is the same in both cases.

Therefore, all of the information contained in the link budget is accurate, is referenced to the ITU, FCC or to the DBS industry as a source, and in some cases has been verified in testing. Moreover, the most conservative values are used in all cases. Unequivocally, it is highly unlikely for all of the worst-case values to occur at the same time for any DBS user. In any case, even at all the worst-case values, a C/I of 9 dB will not cause harmful interference into DBS.

2.1.2 Maximum Allowable Link Degradation due to Terrestrial Interference.

The DBS link tolerates a carrier to interference level of 8 dB (as shown in Figure 10, and Table 4), in rain, at the stated availability of 99.7% or greater. That is to say, a C/I of 8 dB from terrestrial sources will neither cause an outage, nor seriously degrade the signal of DBS customers, even during rain. Although a C/I of 8 dB will not cause harmful interference, Northpoint Technology will provide a much higher level of protection throughout the service area.

[18] Appendix S30, Section 2.3, Annex 5
[19] Reference 2 at 3.
[20] Reference 3 at 36.

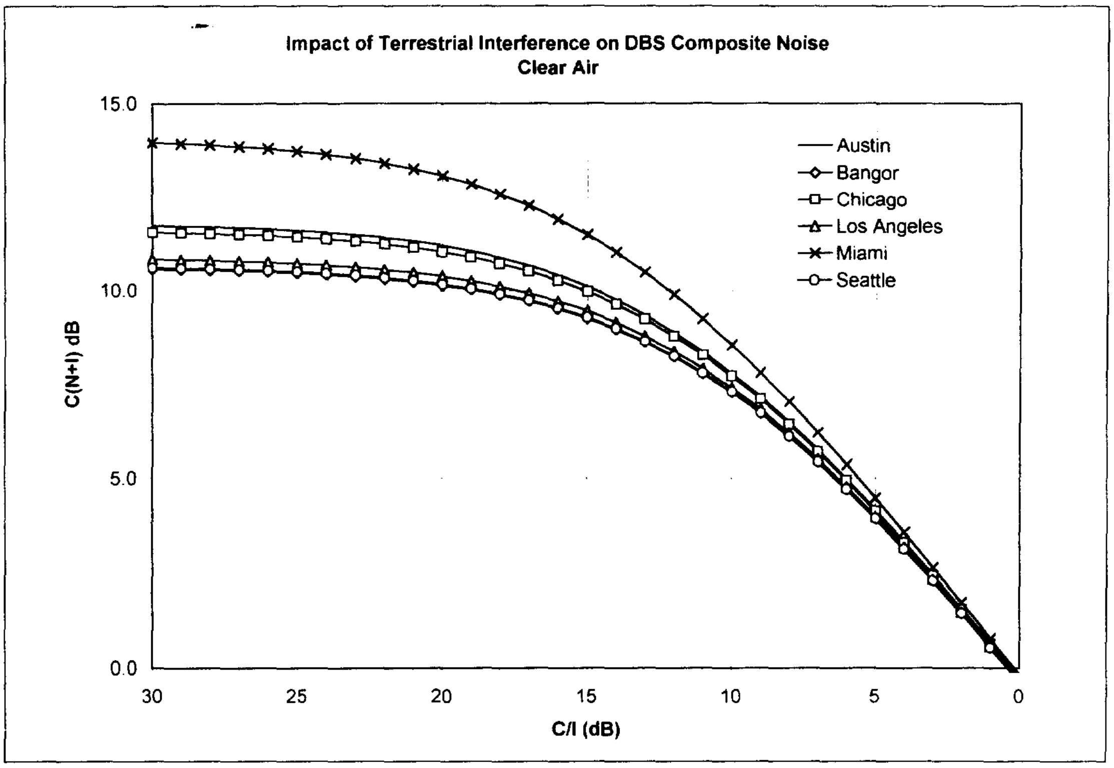

Figure 9. Terrestrial effect on C/(N+I), Clear Air

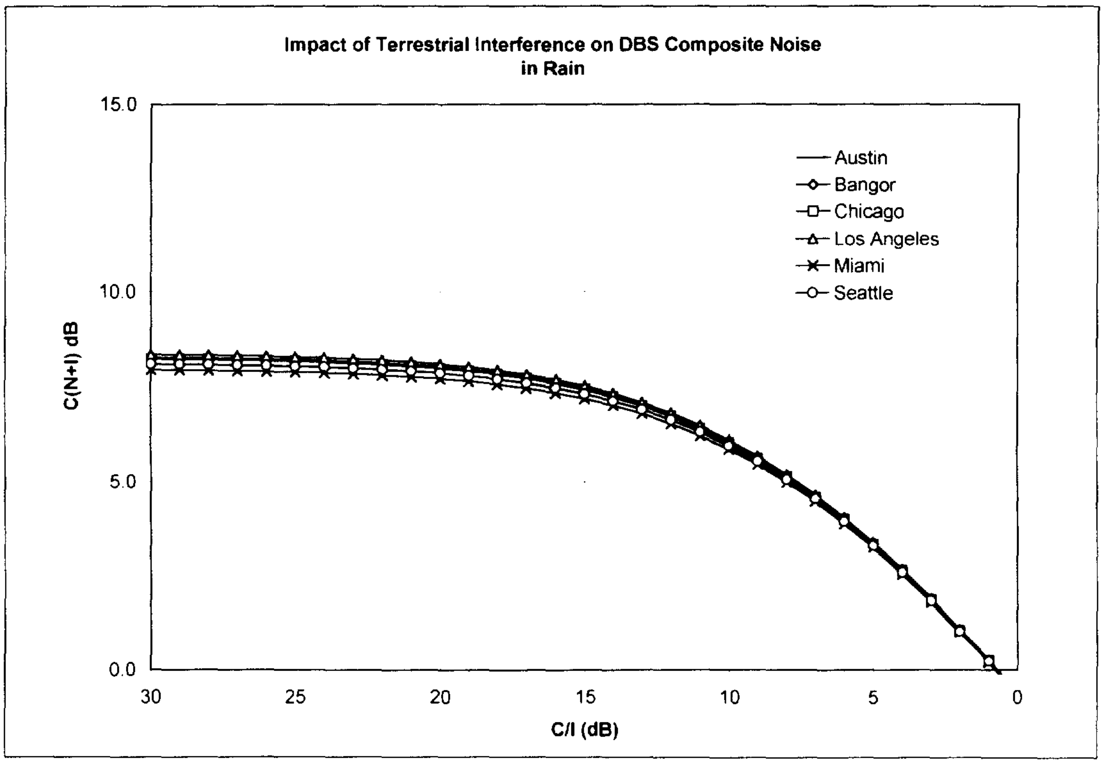

Figure 10. Terrestrial Interference Effect on DBS Link C/(N+I) In Rain

2.1.3 Maximum Link Degradation Due to Interference from Northpoint.

Northpoint Technology will automatically provide a minimum carrier to interference ratio of 24 dB to 99% of all DBS customers, 20 dB to 99.5%, and 17 dB to !00% of DBS customers. As seen in Table 6, a C/I of 20 dB from terrestrial sources causes a noise increase of only 0.3 dB. For all DBS links, a noise increase of 0.3 dB equates to a reduction of availability of less than 0.01%, or less than 0.9 hours per year. Put in other terms, an increase in noise of 0.3 dB might cause loss of a DBS signal 1 or 2 seconds earlier during a rain outage. This is nearly impossible to detect.

Table 6. Link Degradation, In Rain, Terrestrial C/I = 20 dB

	Austin	Bangor	Chicago	Los Angeles	Miami	Seattle	units
EIRP	51.0	50.0	51.0	50.0	54.0	50.0	dBW
Downlink Path Loss	-205.6	-206.1	-205.9	-205.8	-205.7	-206.0	dB
Elevation Angle	54.6	29.3	39.3	46.3	52.0	31.3	deg
Availability	99.80%	99.70%	99.80%	99.90%	99.70%	99.85%	%
Atmospheric Loss	-0.08	-0.13	-0.12	-0.09	-0.08	-0.13	dB
Rain Loss	-1.8	-1.0	-1.6	-1.1	-3.6	-1.1	dB
Rain Temp Increase	-2.5	-1.7	-2.3	-1.8	-3.6	-1.8	dB
Pointing Loss	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	dB
Ground G/T	13.0	13.0	13.0	13.0	13.0	13.0	dB/K
Bandwidth	-73.8	-73.8	-73.8	-73.8	-73.8	-73.8	dB
Boltzmann's	228.6	228.6	228.6	228.6	228.6	228.6	dBW/Hz-K
Downlink C/N (Thermal)	8.5	8.7	8.6	8.7	8.5	8.4	dB
Uplink C/N	24.2	24.2	24.2	24.2	24.2	24.2	dB
Crosspol Interference	22.7	22.6	22.5	22.8	22.1	22.6	dB
Adjacent Satellite Interference	25.0	25.0	25.0	25.0	25.0	25.0	dB
Total C/(N+I)	8.1	8.3	8.2	8.3	8.1	8.1	dB
Terrestrial Interference	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	dB
Total C/(N+I)	7.8	8.0	7.9	8.1	7.9	7.8	dB
C/N Required	5.0	5.0	5.0	5.0	5.0	5.0	dB
Link Degradation from Terrestrial	0.27	0.28	0.28	0.29	0.27	0.27	dB
Residual Margin	2.8	3.0	2.9	3.1	2.9	2.8	dB

Terrestrial interference at a maximum value for C/I of 20 dB will neither repeatedly interrupt nor seriously degrade DBS service. A C/I of 20 dB will cause no more than 0.3 dB of degradation to the DBS link, even in rain. A C/I of 24 dB causes no more than 0.1 dB of degradation. It is worth repeating that the Northpoint Technology automatically provides a C/I value of 20 dB or greater to more than 99.8% of DBS customers within the Northpoint service area. Note moreover, that natural shielding will protect the majority of DBS customers from terrestrial emissions to the North. For the remaining 0.2%, in the case of problems with customer equipment (i.e., poorly pointed or positioned DBS receive antenna) Northpoint Technology can ameliorate the interference through one or more of the techniques stated in Section 2.2.1.

2.2 Northpoint Technology will not interfere with DBS.

The Northpoint technology will not interfere with DBS. Northpoint Technology will never cause a loss of signal in clear air, and any modest increase in background noise from Northpoint Technology will not seriously degrade the DBS signal reception.

2.2.1 Interference Mitigation

The minimum carrier to interference isolation in the worst case is plotted in Figure 11. The worst case for DBS is a 0 dBi gain towards the Northpoint transmitter, and this is a rare and unusual circumstance. Most DBS customers will have isolation far greater than 0 dBi, up to -16 dBi or higher. Note the C/I ratios given in Figure 12.

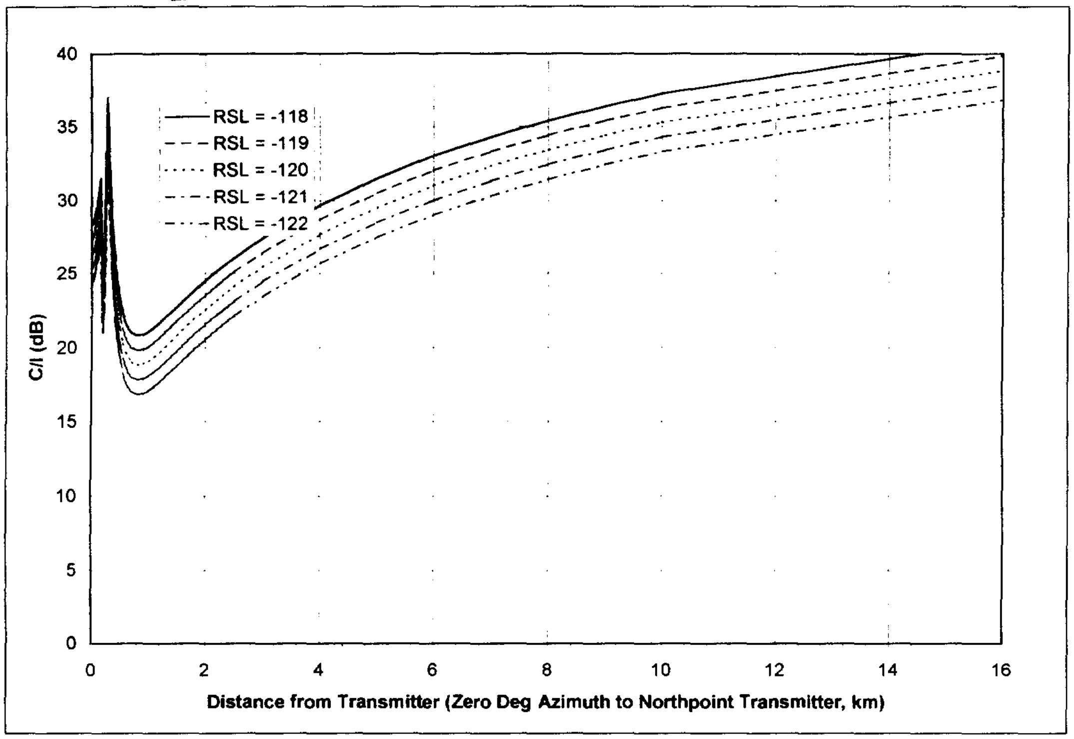

Figure 11. Worst-case C/I ratios

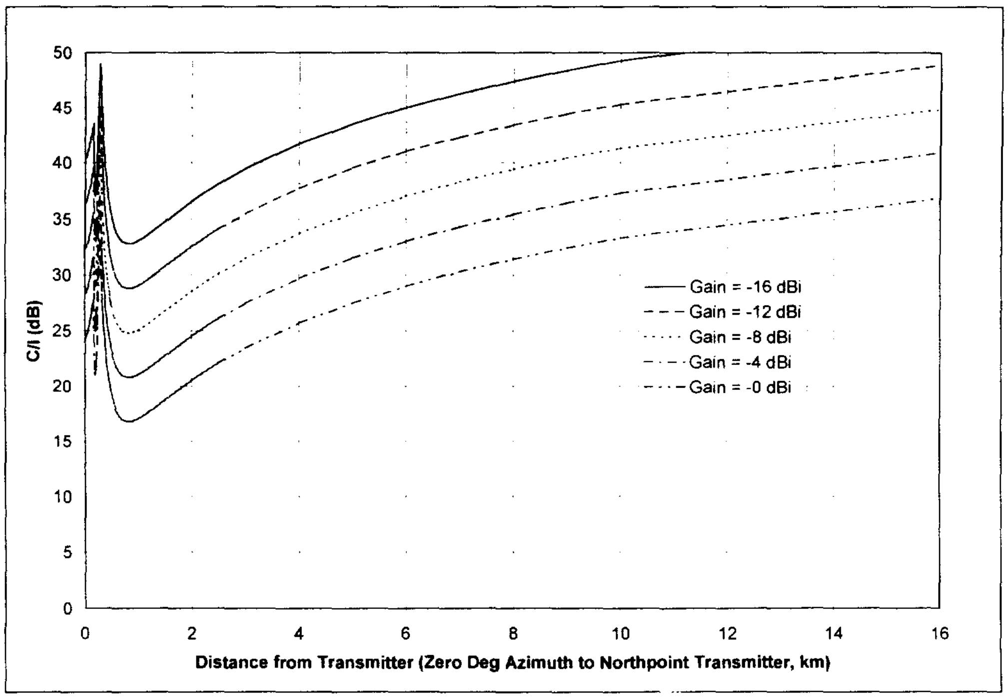

Figure 12. Typical C/I for variation in DBS gain towards Northpoint Transmitter

In section 2.4 it is shown that the worst-case of about C/I = 17 cannot occur for more than 0.2% of DBS customers. Therefore, in addition to the techniques identified in section 1.1.2, terrain blockage, and if necessary, modification of DBS customer equipment will completely eliminate any interference of DBS signals, as explained in the following paragraphs.

Natural Shielding and Terrain Blockage— It is important to note that in any mitigation zone that might exist, attenuation due to terrestrial blockage will also contribute in reducing interference.[21] Importantly, Most DBS antenna installations are placed below the roofline, to the south of the customer dwelling. The antenna manufacturers, as well as DBS receiver manufacturers Sony and RCA, recommend roof-top installations only as a last resort. Attenuation due to terrestrial blockage will also protect a significant percentage of DBS users. If one assumes, conservatively, that only half (50%) of the possible installations in the mitigation zone are below roof top (lack of line of sight), this further reduces the number of affected DBS subscribers in any mitigation zone.

Modification of Customer Equipment— As described in section 2.4, 99.5% of all DBS customers in the service area will automatically have 100% protection from all Northpoint emissions. In the extremely rare case where there is interference, the licensee will bear the burden of preventing interference to the few users affected. Specifically, the licensee will modify, upgrade or otherwise protect any affected DBS customer, at its own expense. The use of these techniques can add sufficient margin to eliminate any interference. The techniques employed in these cases include:

- *Repositioning poorly pointed DBS antennas to eliminate pointing losses.*
- *Replacing the standard DBS antenna with one with better rejection characteristics.*
- *Relocating DBS subscriber receivers away from line-of-sight of the Northpoint transmitter.*
- *Installation of shielding to protect DBS customers.*

2.2.2 Maximum background noise increase from Northpoint Technology.

The interference mitigation techniques employed by Northpoint Technology automatically provide a wide safety margin, as discussed elsewhere in the document. Refer to the figures in Appendix B and the summary in Section 2.4. It can be seen that for 99% of the service area, Northpoint provides a C/I greater than 24 dB, which adds less than 0.1 dB to the noise floor. In some areas of the country, in 0.2% of the service area, a modest increase of 0.3 dB in the thermal noise floor may be seen for those DBS receivers with direct line of sight to the Northpoint transmitter. Again, natural shielding from line-of-sight with the Northpoint transmitter will preclude interference into most DBS installations.

2.3 Northpoint Automatic Level Control

The Northpoint Technology does believe that automatic level control will be required to reduce the EIRP to avoid interference into DBS customers.

2.4 Comprehensive Review of DBS Sharing with DBS throughout the U.S.

Appendix B provides C/I contours for the entire U.S., covering all rain regions, geographical locations and GSO arc locations. Tables 7-9 summarize the information contained in Appendix B. Table 7 identifies the percent of the service area at C/I less than 24 dB, table 8 shows the percent of the service area at C/I less than 20 dB, and Table 9 lists the minimum C/I values. The analysis shows that in there will be no harmful interference into DBS.

[21] DIRECTV agrees that "Natural shielding will occur and reduce interference levels, but cannot be counted upon" Terrestrial Interference in the DBS Downlink Band. Northpoint agrees and asserts that where natural shielding does not protect DBS consumers Northpoint will employ other mitigation techniques to alleviate interference.

Table 7. % Service Area with less than 20 dB Isolation

Satellite Longitude	148	119	101	85	61.5
Austin	0.07%	0.08%	0.00%	0.04%	0.10%
Bangor		0.18%	0.12%	0.08%	0.03%
Chicago		0.11%	0.04%	0.00%	0.09%
Los Angeles	0.17%	0.02%	0.12%	0.19%	
Miami		0.00%	0.00%	0.00%	0.00%
Seattle	0.14%	0.04%	0.14%	0.19%	

Table 8. % Service Area with less than 24 dB Isolation

Satellite Longitude	148	119	101	85	61.5
Austin	0.63%	0.53%	0.31%	0.40%	0.63%
Bangor		0.91%	0.72%	0.61%	0.52%
Chicago		0.69%	0.43%	0.36%	0.58%
Los Angeles	0.92%	0.56%	0.71%	0.92%	
Miami		0.18%	0.15%	0.03%	0.15%
Seattle	0.80%	0.60%	0.73%	0.98%	

Table 9. Minimum C/I isolation

Satellite Longitude	148	119	101	85	61.5
Austin	18.5	18.5	20.3	18.8	17.9
Bangor		17.4	17.4	17.8	19.0
Chicago		18.1	18.8	20.0	18.0
Los Angeles	17.3	19.5	17.4	17.0	18.8
Miami		21.2	20.8	22.7	21.4
Seattle	17.0	19.1	17.1	17.2	

2.5 Summary of sharing between Northpoint and DBS.

In this section, it was demonstrated that Northpoint Technology is fully compatible with DBS. Northpoint will never cause an outage to DBS in clear air, and Northpoint will not significantly degrade DBS signal reception. Indeed, Northpoint power levels are far below degradation levels, and therefore Northpoint will not cause harmful interference into DBS. DBS can tolerate a terrestrial interference C/I level of 8 dB, even in rain and for worst-case assumptions. Interference contours for the entire U.S. are presented in Annex 1. It is seen that Northpoint interference levels are maintained 17 dB below the DBS carrier in 100% of the service area, and 20 dB below carrier in 99.8% of the service area. Terrain blockage will further reduce interference levels. The maximum link degradation due to Northpoint in 99.5% of the service area will be less than 0.1 dB, and less than 0.3 dB in 100% of the service area. In the extremely rare case where 0.3 dB degradation causes interference (due to problems with customer equipment), the licensee can bear the burden of preventing interference to the few users affected.

3 NGSO FSS INTERFERENCE INTO NORTHPOINT

In this section, interference from NGSO FSS systems into Northpoint Technology is considered. In section 3.1, the assumptions are identified. In section 3.2, static analysis is performed to identify those systems that have potential for interference into Northpoint. In section 3.3, dynamic analysis identifies the percentage of time for SkyBridge interfering with Northpoint. In section 3.4, the aggregate PFD mask required to protect Northpoint is identified. In section 3.5, means of establishing *terrestrial arc avoidance* are identified.

3.1 Assumptions

The NGSO FSS systems studied in this analysis are identified in Appendix E, including orbit and RF transmitter system assumptions. All the information contained in Appendix E was taken from filings to the FCC, or derived from information therein.

3.1.1 Interference Criteria for Northpoint

Northpoint interference criteria, for time-varying sources of interference, are given in ITU-R document USRCG9A-Int-1. The Northpoint interference criteria are listed in the following table.

Table 10. Northpoint Interference Criteria

I/N Level	Percent of Time
0 dB	0.001
-13	20

3.2 Static Analysis

A static analysis was performed to identify the worst-case I/N, as a function of elevation angle. The Northpoint receiver is at the edge of coverage, with an elevation angle of 0.5 degrees to the Northpoint Transmitter at HAAT = 150 meters. Atmospheric loss per ITU-R model for gaseous absorption is assumed. The I/N ratio is calculated with equation 3.

$$I/N = P + 10*\log(B/b) + Gtx(theta1) - pathloss(x) + Grx(theta2) - gas - N \qquad \text{(Equation 3)}$$

where:

P	: Transmit power (dBW)
B	: Transmit bandwidth (MHz)
b	: Receive bandwidth (MHz)
theta1	: off-bore sight angle to victim from transmitter
Gtx(theta1)	: Gain of transmit antenna in direction of victim (dBi)
x	: distance from transmitter to victim (km)
pathloss	: free space loss (dB)
theta2	: off-bore sight angle to transmitter from victim
Grx(theta2)	: Gain of victim antenna in direction of transmitter (dBi)
gas	: gaseous attenuation (dB)
N	: Noise power of victim receiver.

In the case of NGSO FSS, certain variables (*x, theta1, theta2, gas,* and in some cases *P*) change with elevation angle to the interfering satellite, the remainder are constant. Refer to Figure 13 for a visualization of the interference geometry, which is drawn to scale for H = 1469 km (SkyBridge altitude).

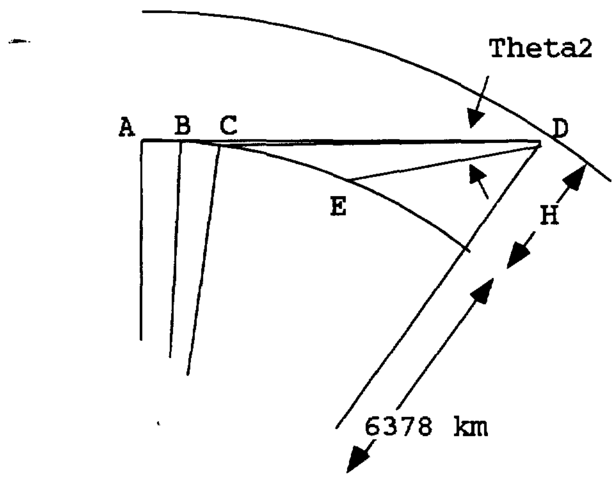

Figure 13. Interference Geometry for NGSO FSS into Terrestrial Services

Table 11 explains the geometry in Figure 13.

Table 11. Interference Geometry for NGSO FSS into Terrestrial Systems

Item	Description
A	Terrestrial Receiver at elevation 0° to interferer
B	Terrestrial Receiver at elevation 5° to interferer
C	Terrestrial Receiver at elevation 10° to interferer
D	Interferer at orbital altitude H
E	NGSO FSS Service Elevation (Elevation angle from NGSO FSS customer to NGSO FSS satellite) (Variable 10 - 90 degrees)
H	Orbital Altitude of Interferer
Theta 2	Off bore-sight angle from NGSO FSS transmitter to victim.

As can be seen in Figure 13, the off bore-sight angle (theta2) can be quite small. For NGSO FSS LEO systems at elevation angles nearing 10 degrees, it is less than one degree. The off-bore sight angle (theta1) is seen to be zero degrees, and so a main-beam on main-beam situation can occur. Using equation 3, interference (I/N) values for NGSO FSS service elevation angles are plotted in Figure 14.

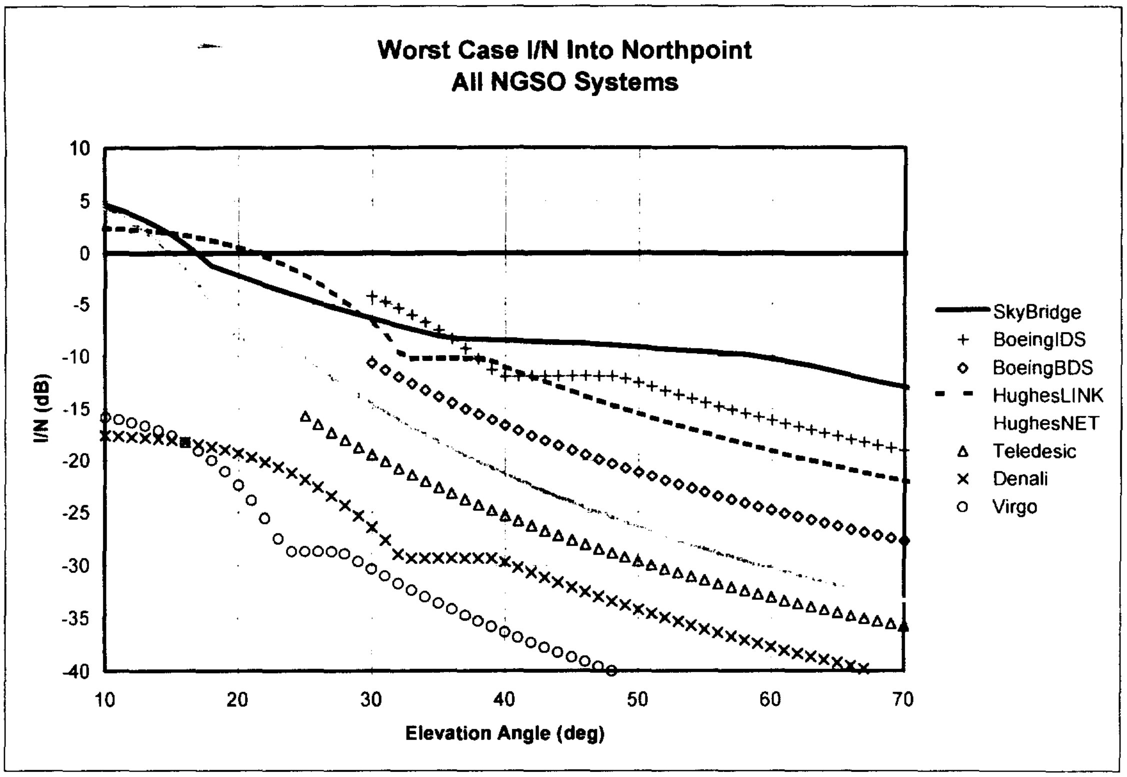

Figure 14. Worst-case I/N into Northpoint Technology

Only three of eight proposed systems could cause interference into Northpoint at an I/N greater than 0 dB (short-term criteria), as shown in Figure 14. The remaining five NGSO FSS systems will not cause a loss of signal in clear air. It is assumed that long term increases in noise temperature are negligible. In the cases of SkyBridge and the two Hughes systems, interference into Northpoint is possible due to the very low discrimination from the NGSO FSS transmitter towards the Northpoint receiver. Dynamic analysis will reveal the extent to which NGSO FSS systems would cause system outages or reduce the system availability of Northpoint Technology (see section 3.3).

Loss of Northpoint service area. Repeated interruption of service will result in a loss of Northpoint service area. As the distance varies between the receiver ant the Northpoint transmitter, the received signal level (RSL) varies due to changes in free space loss. This effect is plotted in figures [TBD]. Within the Northpoint service area, the azimuth angle to the Northpoint transmitter varies up to plus/minus 125 degrees true azimuth. Further, the various NGSO FSS systems operate in orbits with given inclination and orbital altitude chosen by the system designers. The orbital geometry dictates that NGSO FSS operates at certain elevation angles (refer to Appendix C). Loss of signal is possible for only a portion of the Northpoint service azimuths. Of course, any change in system parameters (e.g. satellite inclination angle) or operations (e.g. minimum elevation angle) would change the interference environment from NGSO FSS.

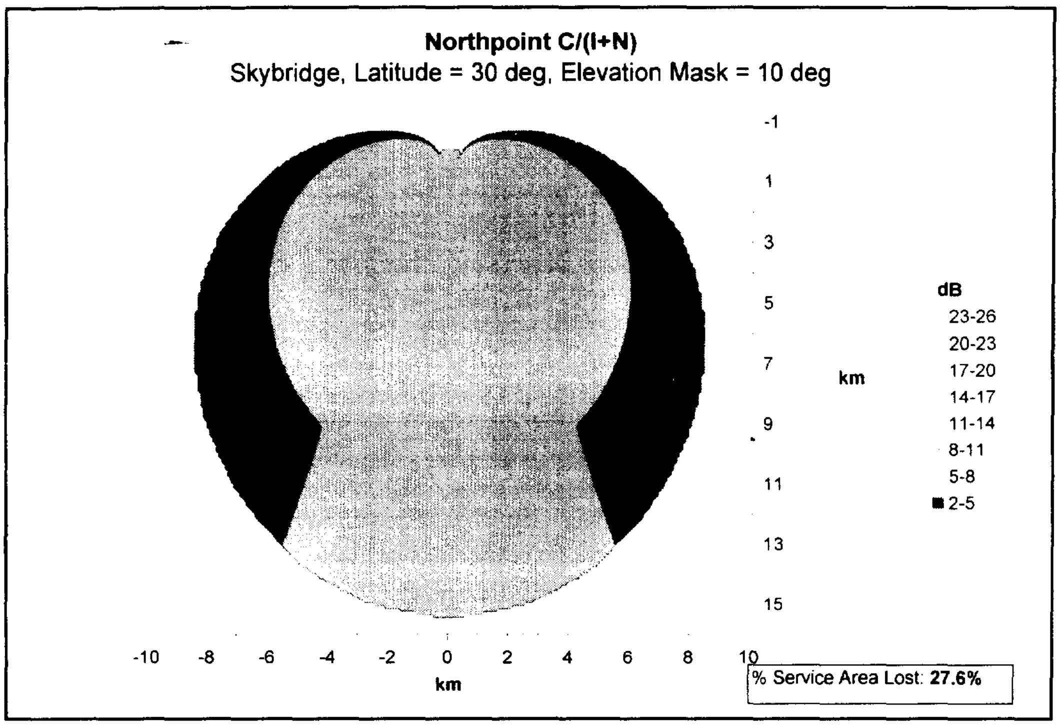

Figure 15. SkyBridge Interference into Northpoint

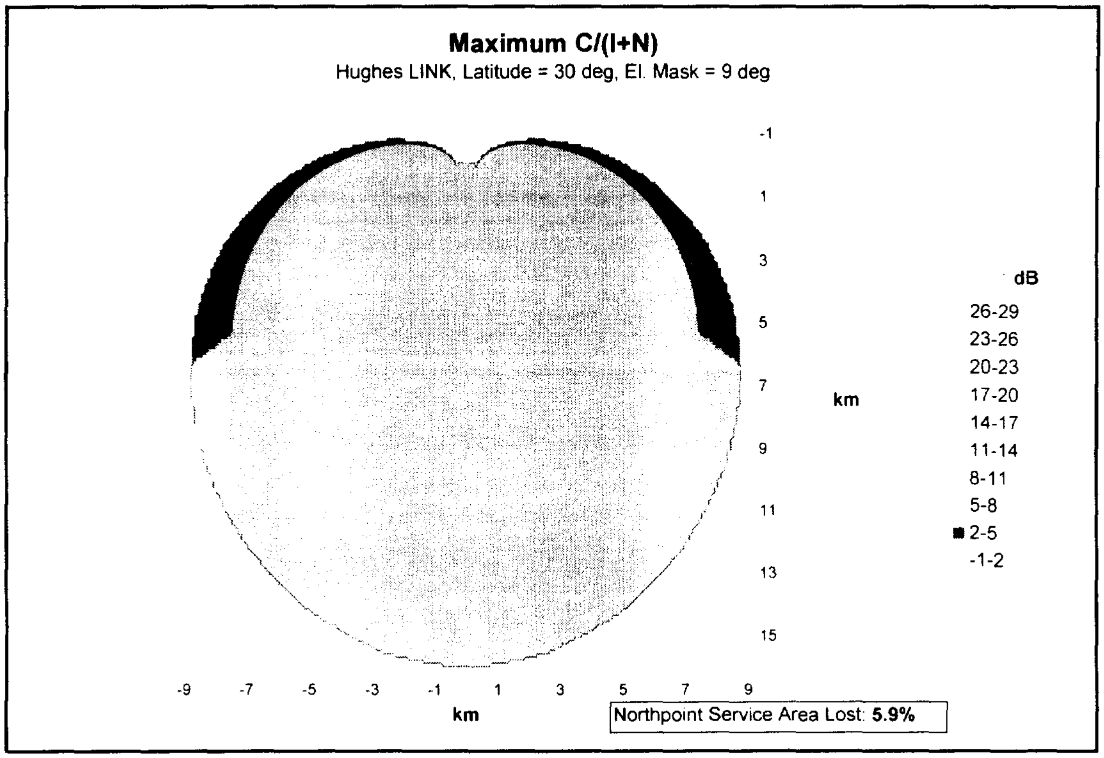

Figure 16. Hughes Link Interference into Northpoint